scenarios to guide the spatial distribution of populations or to adjust demographic components of change. The ICLUS projections are an example of such soft linkages. This approach could be further augmented by developing relationships between global scenarios and localized features not captured in a global setting. How information from global scenarios informs national, state, and county projections (i.e., through hard and soft linkages) has implications for how uncertainty is characterized. There are also path independence issues to overcome. It is important to note that not everything needs to be carried across from global scenarios in order for it to be consistent with U.S. scenarios.

6. Next Steps: Moving Forward with U.S. Demographic Change Scenarios

U.S. population scenarios would improve the ability of USGCRP to inform ongoing climate impacts research, both Integrated Assessment models and Impacts, Adaptation and Vulnerability models, the National Climate Assessment, and decision making at all levels of government and in the private sector. Such scenarios could also form the basis of quantitative projections using demographic and other modeling techniques.

Workshop participants offered many suggestions for moving a USGCRP scenario enterprise forward. These largely fell in three main categories: 1) Adopt measures to improve data coordination and integration, 2) conduct research and develop methods, and 3) develop U.S. population scenarios.

Adopt Measures to Improve Data Coordination and Integration

A. Inventory and evaluate existing datasets (e.g., ACS) and observations to determine how they might be deployed to support development of spatially explicit population scenarios for the United States. A robust data collection effort is necessary for the development of high-quality population forecasts. The evaluation should include a characterization of data availability, strengths, and limitations as well as identification of significant data gaps.

B. Develop coordinated information networks around demographic and key non-demographic factors, such as regional economics, income, environmental amenities, density/congestion, public policies, and housing markets.
    1. Coordinate data collection: Collect data contemporaneously for demographic and non-demographic factors, with the goal of collecting comparable data that can be pooled efficiently.
    2. Standardize metadata protocols: Standardize summary information and put datasets into context in order to facilitate research on important relationships.
    3. Make geospatial population data available in consistent data formats: Developing gridded data for demographic and non-demographic data would facilitate integrated research.

C. Educate users and developers of demographic scenarios about the current levels of uncertainty in data spanning various spatial, temporal, and demographic detail dimensions.
D. Reach outside of traditional USGCRP communities to demographers and state and local planners. An ongoing dialog would inform both groups about the feasibility and utility of scenario approaches.

Conduct Research and Develop Methods

A. Develop an MIP to compare national-scale spatially explicit projection methods including Proportional Scaling, Trend Extrapolation, Cohort- Component/Economic hybrids, Gravity-based, and Cohort Component/Gravity-based hybrids.
    - MIP should also compare against historical data and against aggregate projections.
B. Conduct a "bake off" between alternative approaches to allocate populations at sub-county levels, such as the distributive housing unit method, various extrapolation techniques, multiple regression (knowledge-based) approaches, cohort-change ratios methods (e.g., Hamilton-Perry), integrated land use models, and grid cell extrapolation.
C. Conduct basic research to discover generalizable relationships between non-demographic variables and how they influence population size/composition/distribution over time.
    - ACS could be important for the development of this knowledge.
D. Improve methods to understand the dynamics of U.S. migration between regions, states, counties, and sub-county areas.
E. Explore a hierarchical approach (i.e., adaptive mesh) for developing population projections with scale-appropriate population characteristics.
    - Investigate city growth approaches/detailed agent-based modeling to determine whether they can be scaled up to larger geographic areas.
F. Investigate the utility of new data sources, such as social media, "big data," and remotely sensed data, for observing, understanding, and projecting population.
G. Explore how climate change impacts, especially disruptive events, can be incorporated into demographic scenarios and projections. Direct effects, behavioral responses (i.e., secondary effects), and indirect effects from teleconnections should be evaluated.

Develop U.S. Population Scenarios

A. Evaluate the Representative Concentration Pathways and Shared Socioeconomic Pathways to determine their utility for a U.S. scenario enterprise. Evaluation should include comparisons with previous global scenario efforts (e.g., IPCC Special Report on Emissions Scenarios, Millennium Ecosystem Assessment) to identify similarities and points of divergence at national, regional, state, and county levels.
B. Engage demographers in developing national, spatially explicit population scenarios.
C. Focus developmental efforts on a pilot project: U.S. scenarios feeding into the next National Climate Assessment.
    1. Develop alternative scenarios focused on:

a. Migration between regions (e.g., migration between the Northeast and Southwest regions) and among states. These scenarios can be used to explore "what if" situations that are of particular interest to regional stakeholders.
b. Urban development patterns (e.g., urban infill, dispersion to exurban and rural areas, consolidation of suburban centers).

2. Work with end users/local governments to ensure top-down, demographically driven, spatially explicit population scenarios can be merged with participatory, bottom up scenarios that can incorporate detailed, localized data (e.g., zoning changes, housing development, and tax rates/assessments).